Developing a Relative Flash Flood Potential Index to Assist in the Flash Flood Warning Decision Making Process

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Concept:

Take a look at physical land surface characteristics that influence the hydrologic response to heavy rainfall.

An area containing physiographic features conducive to rapid and significant runoff from rainfall would be identified as having a greater flash flood potential threat relative to areas generating less runoff over longer periods of time.

Determine a simplistic flash flood potential index, on a relative scale, from this analysis. Utilize this information to supplement FFMP and in attempts to generate finer resolution FFG.

Physiographic – Refers to the character and distribution of land forms.
Additional information perhaps helpful to know

- Soil type?
- Fire activity?
- Land Use?
- Vegetation type and density?
- Slopes?
- Is the ground frozen?
Hydrologic Response To Heavy Rainfall

- Frozen Ground -

Flow Magnitude

Less  More

Slower  Rapid

Flow Response Time

Lower  Greater

Flash Flood Potential
Accumulating Knowledge About A River Basin
Evaluating The Flash Flood Threat

Hundreds or Thousands of Basins Under One Radar Umbrella !!
A Better Method: Utilizing GIS tools/methods to develop a single index that represents the potential for flash flooding (on a relative scale)

obtain raster (gridded) datasets representing the features of interest
Assign grid cell FFPI values of 1-10 based on attributes of the data layer:

- Slope
- Vegetation
- Soil Type
- Land Use

Output: Mean of all the data layers
Continuous Data Types

Equal Interval Classification

<table>
<thead>
<tr>
<th>Slope Percent - Orig</th>
<th>FFPI</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 10</td>
<td>1</td>
</tr>
<tr>
<td>10 - 20</td>
<td></td>
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<tr>
<td>20 - 30</td>
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<td>90 - 110</td>
<td></td>
</tr>
<tr>
<td>No Data</td>
<td>10</td>
</tr>
</tbody>
</table>
Urban Development along the Colorado River

The purpose of using this dataset is to highlight the urban areas.

Significant concern for WFO’s central/eastern U.S.
Land-Use Dataset for Front Range of Colorado
**Method (Initial)**

\[
\text{RFFPI} = (1.5 \times \text{slope} + 1.0 \times \text{forest} + 1.0 \times \text{soil} + 1.0 \times \text{LU}) / N
\]

\[
\text{RFFPI} = \text{Relative Flash Flood Potential Index}
\]

Slope = Percent Slope

Forest = Forest Cover

Soil = Soil Type (fractional soil grid)

Land Use = Land Use Type

N = Number of Layers

More layers will be added
Gridded –Relative– Flash Flood Potential
Summarize Grids to FFMP Basin Layer

- STATSGO Dominant Soil Texture
- MLRC Land Use / Land Cover
- NOAA AVHRR Forest Density Grid
- USGS DEM (derived % slope Grid – Terrain)
- Fire Burn Areas / Severity coverage

FFMP Basins

- Low
- High

Relative Flash Flood Potential

An indication of rapid hydrologic response
Additional information perhaps helpful to know

Soil type?

Vegetation type and density?

Land Use?

Fire activity?

Slopes?
Flash Flood Occurred

Circleville
Flood Rescue

11,000 CFS rise in just over an hour
So How Might This Be Utilized?

Supplement FFMP and provide additional information in the flash flood warning decision making process

As a starting point for an alternate method creating FFG

- Takes into account physiographic features influence flash flooding
- Incorporates observed FF event information
- CBRFC: Spatially vary current zone FFG from the Legacy System
Accounting For Effect of Wildfires

John McColgan – BLM Firefighter
High Burn Severity:
All vegetation blackened, deep soil heating killing roots/seeds, “baking” of the soil surface.

Low Burn Severity:
Most vegetation untouched by fire. No significant Effect on soil properties or water repellency.

Moderate Burn Severity:
Patchwork of green and burnt areas. Intermediate Between “high” and “low” severity levels.
The Challenge: How to apply fire burn severity information?

Forest Density Layer:
- High Burn Area – Completely removed forest density
  Maximized hydrologic response for this layer
- Moderate Burn Areas - Reduced forest density by 50%
  Moderate increase to hydrologic response for this layer
- Low or non burn areas – No change to existing forest density
  No change to hydrologic response for this layer.
The Challenge: How to apply fire burn severity information?

Soil Type Layer:

- High Burn Area – Assume hydrophobic soil
  Maximized hydrologic response for this layer

- Moderate Burn Areas – Mix of baked / non-baked soil exists
  Moderate increase to hydrologic response for this layer

- Low or non burn areas – No change to existing soil properties
  No change to hydrologic response for this layer.
Affect of Fire on Hydrologic Response and Gridded Relative Flash Flood Potential

* Preliminary Results *

Burn Severity Layers Applied

Relative Flash Flood Potential Index

- No change in low burn areas
- Significant increase in high burn areas
- Moderate increase in moderate burn areas

Prepared by: Greg Smith - Colorado Basin River Forecast Center - NWS/NOAA
This is inside a national park; is that a risk factor to consider?
Limitations & Challenges

GIS Datasets

Resolution issues, derived data, source information, accuracy issues, applicability, error propagation, etc.

Wildfire Data

No clearinghouse for obtaining such information – Incorporate wildfire recovery.

Observed FF Event Information

Limited, scattered, time consuming to acquire.

Current Assumptions – Layer Weighting Schemes

Observed event data needed for more robust application

Finding the Right Platform

How best to display – utilize such information.
Utah Flash Flood Events
1959-2003